ELGAR

SMARTWAVE™

Programmable AC/DC Power Source

Applications

- Avionics Testing
- Power Line Simulation
- Production Test
  - Power Supplies
  - UPS
  - Telecom

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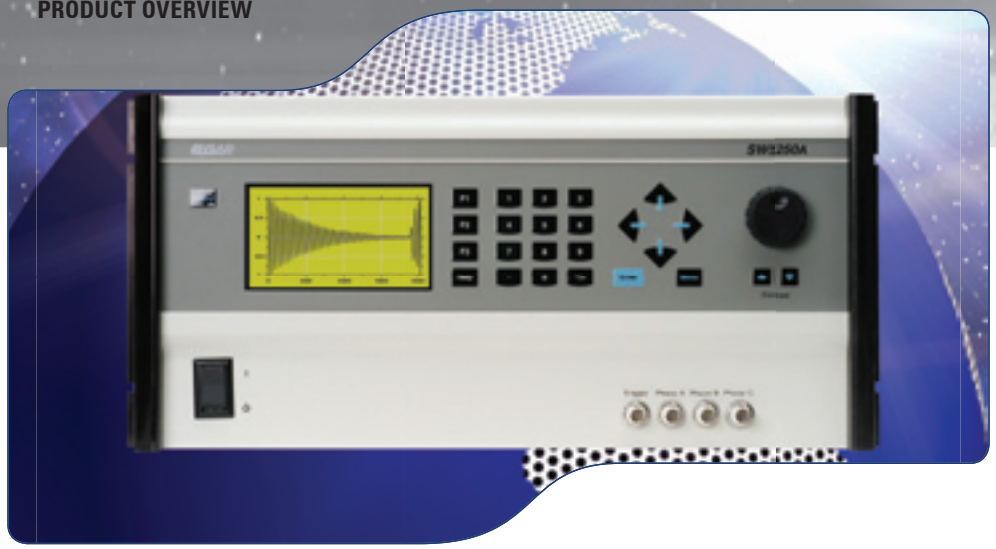
eec™

SMARTWAVE

SMARTWAVE™ (SW)

PRODUCT OVERVIEW



Product Overview

The SmartWave™ (SW) Series of AC power sources offers powerful waveform creation for ATE and power line disturbance simulation testing. Three separate arbitrary waveform generators enable the SmartWave to create independent, complex waveforms on all three phases simultaneously. The SmartWave is designed to meet waveform requirements including DC content (up to 312V), low distortion (THD 0.25% to 100 Hz), low noise and ripple, plus full compliance testing to various EMC and avionics standards.

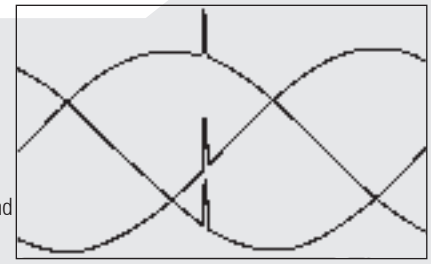
At only 8-3/4 inches high for the SW 5250A, the SmartWave delivers the most power in the smallest package. It weighs only 127 pounds, and offers the highest power density in the industry. The SW Series is expandable from 1.75 kVA to 21 kVA. Unlike other AC power sources, the SmartWave delivers full rated power to 45ºC.

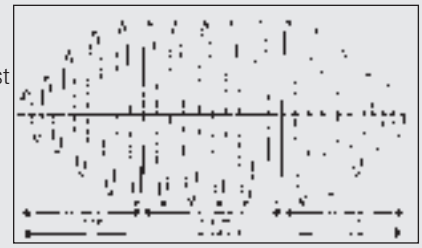
Features and Benefits

Powerful Waveshape and Waveform Creation

The SmartWave can easily create fractional or multi-cycle dropouts, spikes, surges, sags and distorted waveforms from the front panel. To simulate these complex real-world power occurrences, the SmartWave comes with a library of 50 built-in waveshapes (see examples on page 3). Users can create and store an additional 50 waveshapes of their own design.

Output voltages are created by adding amplitude, frequency and other parameters to the waveshapes. The user can also create over 50 custom front panel setups with all parameters included and store them for quick recall, making the SmartWave ideal for manual testing.





Sequences can be constructed with segments defined by time or number of cycles.

Sequence Programming

Complex sequence or event programming is easy with time or cycle based transient segments. The sequence library is made up of a total of 1000 segments stored as labeled sequences.

A sequence of up to 100 segments using up to 32 different waveshapes, arranged in any combination, can be run at any one time. The 32 waveshapes can be selected from the 50 factory supplied and 50 user created waveshapes. By setting the time or number of cycles for each segment, the user can create waveform sequences that allow automatic testing for most any standard.

AC and/or DC

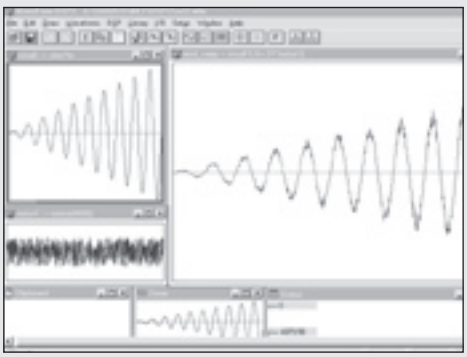
A direct coupled, transformerless design allows AC and DC on separate phases or on the same phase. The SmartWave can be used as a true DC power supply. High DC content waveforms (up to 312 volts) can be created with no derating of output power, even with 100% reactive loads, eliminating the need for a separate DC supply.

Graphic LCD Display

The SmartWave has a graphic LCD display for previewing and confirming the waveforms before connecting the output to the load. Users can select menus, and slew voltage and frequency with a handy knob on the front panel. Front panel signal and sync outputs allow three phase scope viewing.

Powerful DSP2 Waveform Programming

Waveform programming is easily accomplished using the optional DSP PC software. The software allows freehand creation of waveforms, using a mouse or mathematical expressions. Real-world waveforms can be uploaded and modified when using a digital scope. The waveforms can then be downloaded to the SmartWave via GPIB and output to exactly simulate real-world conditions.

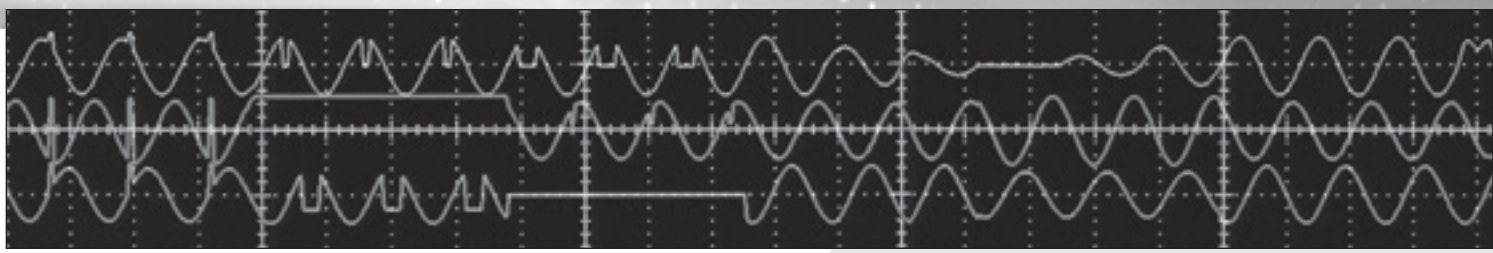


WaveForm DSP2 Creation Software Screen

CE

SMARTWAVE™ (SW)

WAVEFORMS & APPLICATIONS



As shown by this photo, the SmartWave can create time coincident spikes on 3 phases, fractional or multi-cycle dropouts, sags and surges, waveforms distortion, DC and noise.

Flexibility in Power Ranges

The SmartWave series includes the SW 1750 (single phase only), SW 3500 (single or dual phase), and SW 5250A. The 5250A three phase unit can be switched to single phase or vice versa, simply by menu selection (and appropriate output wiring changes). The SW Series is factory upgradable from 1750 VA to 3500 VA or 5250 VA. Utilizing a master/slave arrangement, SW 5250A can be paralleled for incrementally higher power requirements, e.g. one master/one slave = SW 10500 (10.5 kVA). As many as 3 slave chassis may be paralled with a master to form a 21 kVA system. Options include input power factor correction, measurement capability, plus 5 and 26 VAC auxiliary outputs.

Waveshape Library

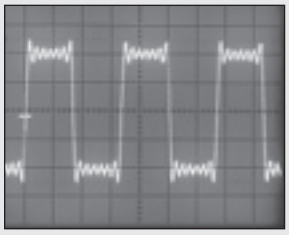
There are 50 factory-supplied waveshapes in the SmartWave. Following are examples of the types of waveshapes in the library:

- Sine wave
- Square wave
- Triangle wave
- Clipped sine waves
- Sine waves with spikes
- Fractional dropouts
- Sine wave with dropout (0V from 0° to 90°)
- Sine waves with ±1-50% DC offset
- ±DC with 3% and 10% ripple
- Fourier square waves with harmonics
- Taylor series waves
- Sine wave with noise at zero crossing

Applications

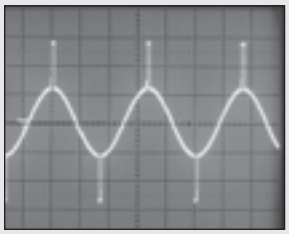
The SmartWave is designed for testing today's complex electronics, including avionics, telecommunications and commercial electronics requiring low profile, light weight power supplies. Other applications include:

- Testing for real world power conditions using different waveforms on all 3 phases (including DC)
- Load susceptibility testing with sequence or event programming and multiple voltage harmonics
- Power line disturbance simulation testing
- MIL-STD-704, DO-160 and ABD100 avionics testing
- Power supply testing for AC-DC, DC-DC converters and UPS's
- Fluorescent lighting characteristics testing (IES LM-41-1985)
- Transients on 12 & 24 VDC for automotive applications



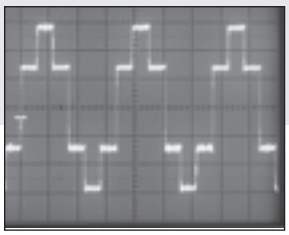
Fourier square wave with first, third, fifth and seventh harmonics

Sine wave with first quarter (0° - 90°) at 0 volts



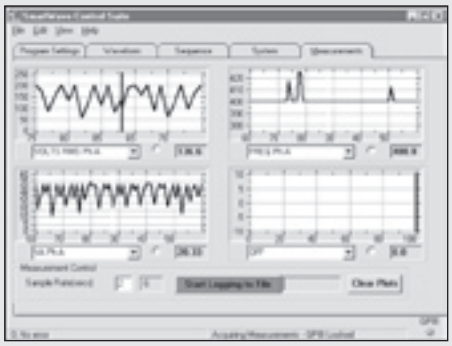
Sine wave with spikes from 85° - 95° and 265° - 275°

Sine wave with a dropout from 45° - 60°

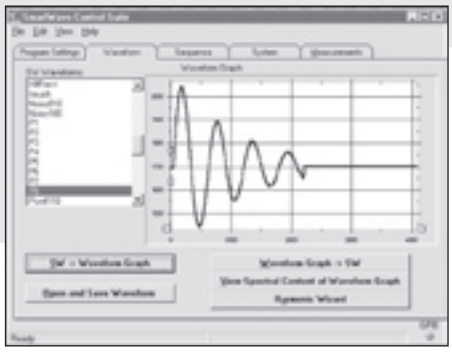


Six step sine wave

Sine wave with the positive halfcycle clipped at OV from 50° - 130°



SWCS Measurement Screen



SWCS WaveForm Screen

SmartWave Control Suite (SWCS)

SWCS is a Windows based software package for computer control of the SmartWave Series and SWAE AC power sources. With the SWCS you have complete control of the instrument including programming, waveform selection, creation and sequencing. SWCS enhances the standard SmartWave features with an additional harmonic waveform analysis capability with data logging features for all measurements.

SMARTWAVE™ (SW)

SPECIFICATIONS

OUTPUT

Output Power: 1750 VA: 1ø, 3500 VA: 1ø or 2ø, 5250 VA: 1ø or 3ø (systems up to 21,000 VA)

AC or DC Output Voltage: 0 to156 VRMS L-N, range 1; 0 to 312 VRMS L-N, range 2

Voltage Accuracy: ±0.1% of range. Above 1 kHz, add 0.2%/kHz. Add ±0.1% of full scale for "AC PLUS DC" mode. Valid for 5 to 156 VRMS and 10 to 312 VRMS at 25°C

Voltage Resolution: 0.05% of full scale

Output Current Per Phase: 13A to 135V in 156V range; 6.5A to 270V in 312V range; optional 16A/8A consult factory (per 1750 VA module)

Note: Higher currents may be achieved in 10.5-21 kVA systems.

Crest Factor: 4.0 (peak output current to RMS output current)

Power Factor of Load: 0 lagging to 0 leading

Output Frequency Range: DC or 40 Hz to 5 kHz. For output frequencies greater than 1 kHz, the max slew rate allowed is 1 kHz per second.

Frequency Accuracy: ±0.01% at 25°C ±0.001%/°C

Frequency Resolution:

40 Hz to 99.99 Hz: 0.01 Hz
100 Hz to 999.9 Hz: 0.05 Hz
1000 Hz to 5000 Hz: 0.5 Hz

Load Regulation: ±0.025% of full scale voltage for a full resistive load to no load; above 1 kHz, add ±0.01%/kHz

Line Regulation (DC, or 40 Hz to 5 kHz): ±0.025% of full scale for a ±10% input line change

Max Total Harmonic Distortion (Full Linear Load or No Load): 0.25% max, 40 to 100 Hz; 0.5% max to 500 Hz; and 1% max to 1 kHz plus 1%/kHz to 5 kHz

Phase Accuracy, Phase-to-Phase Balanced Linear Resistive Load: ±1°, 40 Hz to 1 kHz, plus ±1°/kHz above 1 kHz

Phase Angle Resolution: 0.1°

AC Noise Level: >60 dB RMS below full output voltage

Amplitude Stability With Remote Sense: ±0.1% of full scale over 24 hours at constant line, load and temperature

Remote Output Voltage Sense: 5 VRMS total lead drop, max

WAVEFORM SPECIFICATIONS

Waveshape Libraries: 50 factory supplied in ROM; storage available for up to 50 user created in non-volatile RAM

Front Panel Setups: A total of 50 user created steady-state waveforms, with amplitude, frequency, phase angle and current limit parameters

Sequencing Library: 1000 user created segments stored in non-volatile RAM. Segments include waveshape, amplitude, frequency, phase angle, time (from 1 ms to 1000 seconds), or number of cycles.

MIL-STD-704 Transient Library

MEASUREMENTS (OPTIONAL)

- Phase to Neutral RMS Output Voltages
- Phase to Phase Voltages
- 1ø to 3ø RMS Output Currents
- Peak Current
- Output Frequency
- 1ø to 3ø Power
- 1ø to 3ø VA
- Power Factor of 1ø or 3ø Loads
- Output Phase Angles Relative to Phase A

Measurement Capability: 4.5 Digit Analog to Digital Measurement System with .01% of full scale resolution unless otherwise noted.

Calibration Interval: 12 months

Temperature Range for specified Accuracy: 25°C to ±5°C unless otherwise noted

Phase to neutral RMS voltage measurement: Valid for phases A, B and C (use phase A for Parallel Mode)

- **Range:** 0V to 350V plus sign bit for DC range
- **Accuracy:** ±0.3% of range, DC or 47 Hz to 1 kHz; ±0.5% of range, 40 to 47 Hz and for 1 kHz to 5 kHz

Phase to phase RMS voltage: Calculated from Phase to Neutral voltages and phase angle

- **Range: 0V to 700V**
- **Accuracy and Temperature Coefficient:** The same as the Phase to Neutral voltage

RMS current measurement: Valid for phases A, B, and C (use phase A for Parallel Mode)

- **Range 1: 0A to 7.5A, plus sign bit for DC range; 3ø mode, 312V range**
- **Range 2: 0A to 15A, plus sign bit for DC range; 3ø mode, 156V range**
- **Range 3: 0A to 22.5A, plus sign bit for DC range; parallel mode, 312V range**
- **Range 4: 0A to 45A plus sign bit for DC range; parallel mode, 156V range**
- **Accuracy: ±1.0% of range, DC or 40 Hz to 500 Hz; add ±1.5%/kHz above 500 Hz**

Accuracies are specified for a max crest factor of 4.0

Note: Contact factory for measurement range on 10.5 to 21 kVA system.

Peak current measurement: Valid for phases A, B, and C (use phase A for Parallel Mode)

- **Range 1: 0A to 28A; 3ø mode, 312V range**
- **Range 2: 0A to 56A; 3ø mode, 156V range**
- **Range 3: 0A to 84A; parallel mode, 312V range**
- **Range 4: 0A to 168A; parallel mode, 156V range**
- **Accuracy:** ±5% of range, 40 to 500 Hz; add ±1%/kHz, 500 Hz to 5 kHz

Power Measurement: Valid for phases A, B, and C. Up to 3ø total power and parallel mode (use phase A for Parallel Mode)

- **Range 1:** 0 kW to 1.8 kW; 3ø mode
- **Range 2:** 0 kW to 5.6 kW; parallel mode and total 3ø power
- **Accuracy:** ±2.5% of range, DC or 40 to 500 Hz for crest factors <2.0. Add ±1% for crest factors up to 4.0. Add ±1%/kHz above 500 Hz

VA Measurement: Valid for phases A, B, and C. Up to 3ø total VA and parallel mode (use phase A for Parallel Mode)

- **Range 1:** 0 kW to 1.8 kVA; 3ø mode
- **Range 2:** 0 kW to 5.6 kVA; parallel mode and total 3ø power
- **Accuracy:** ±2.5% of range, DC or 40 to 500 Hz for crest factors <2.0. Add ±1% for crest factors up to 4.0. Add ±1%/kHz above 500 Hz

Power Factor: Valid for phases A, B, and C (use phase A for Parallel Mode)

The Power Factor is calculated from the Power and VA measurements

- **Range:** 0 to 1.00
- **Accuracy:** ±5% of range at full power, DC or 40 to 500 Hz for crest factors <2.0. Add ±2% for crest factors up to 4.0. Add ±1%/kHz above 500 Hz

Frequency Measurement: Frequencies are calculated based on output zero crossing time measurements

- **Resolution:** Frequency is displayed to 5 digits max; leading zeros are blanked. Displayed resolution is 0.01 Hz
- **Accuracy:** ±0.5% of reading, at 10% to full output voltage, 0°C to 45°C

Phase Measurement: Valid for phases A, B, and C relative to each other

- **Resolution:** ±1°
- **Accuracy:** ±2°, 40 to 500 Hz; add ±2°/kHz above 500 Hz. For sine wave, balanced resistive load, 10% to 100% of voltage measurement range, 0°C to 45°C

INPUT

Input Voltage Ranges: Factory configured 187 to 264 VRMS, 3ø L-L (3 wire), or 342 to 457 VRMS, 3ø L-L (4 wire). A chassis ground is also required. 115 or 230 VAC single-phase is required for PDU in 10.5-21 kVA systems. (400 Hz input allowed with PFC option)

Input Power Factor: 0.6
(.35 for Intl. Rectifier; 0.99 with PFC option)

Note: With PFC option the inputs may be paralleled and wired for single phase input. Consult factory.

Input Frequency Range: 47 to 63 Hz

Efficiency: 70% min., at full load

Ride Through: 3 ms min.; 10 ms min., with PFC option

PROTECTION AND SAFETY

Overvoltage Shutdown: Programmable for 15V to 255V peak, 156V range; 30V to 510V peak, 312V range

Programmable Current Limit Shutdown: Settable to 1% of range (0.5A to 13A for 156V range; 0.5A to 6.5A for 312V range)

Programmable Current Limit with Timed Shutdown: Settable to 1% of range: the timeout is settable from 100 ms to 10s.

Programmable Constant Current: Settable to 1% of range (0.5A to 13A for 156V range; 0.5A to 6.5A for 312V range). For all current accuracies ±1% of fullscale, add ±1.5%/kHz above 500 Hz. For paralleled amplifiers, add ±1%.

Overtemperature Shutdown: (automatic, not programmable)

Designed to Meet the Following:

- EN 61010
- EN 55011
- UL 3111
- EN 50082-2
- 61000-4-3, 61000-4-4
- FCC Part 15, Class A
- CE Mark

PHYSICAL SPECIFICATIONS

Height: 8.75 in (222 mm)

Width: 19 in (483 mm)

Depth: 23.5 in (597 mm)

Weight:

- SW 1750A - 73 lbs (33.1 kg)
- SW 3500A - 100 lbs (45.4 kg)
- SW 5250A - 127 lbs (57.5 kg)

Shipping Weight:

- SW 1750A - 160 lbs (73 kg)
- SW 3500A - 180 lbs (82 kg)
- SW 5250A - 200 lbs (91 kg)

Note: 10.5, 15.75 and 21 kVA systems, dimension and weight are approximately x2, x3 and x4 SW 5250A specifications

Cooling: Air is drawn in from the top, bottom, and sides and exhausted through the rear

ENVIRONMENTAL DATA

Operating Temperature: 0°C to 45°C (32°F to 113°F)
Storage Temperature: -40°C to 70°C (-40°F to 158°F)
Humidity (Non-condensing): 0 to 85% at 25°C (77°F); derate to 50% at 40°C (104°F)

Altitude: Operating 10,000 ft, non operating 40,000 ft

OTHER STANDARD FEATURES

- 1ø to 3ø programmable
- IEEE-488.2 interface
- SCPI protocol
- WaveForm trigger output: (1 MΩ Load Drive)
- BNC outputs for scope viewing of waveforms (1 MΩ Load Drive)
- **SYNC OUT. User programmed for:** Cycle start, all cycles. Segment start, all or selected segments. For loads ≥ 2 kΩ: V out ≤ 1V low state; V out ≥ 2.4V high state
- **External Amplitude Modulation** 0 to 5 VRMS provides 0 to ≥ 20% output amplitude modulation
- **Clock/lock:**
  Clock - pulses at programmed frequency. For loads ≥ 2 kΩ V out: ≤ 1V low state; V out ≥ 2.4V high state
  Lock - locks output to input 'TTL' frequency; signal needs to supply pull down current of 15 mA with voltage drop of ≤ 0.6V; no pull up needed
- **External Drive:** Normal amplifier, 0 to 5 VRMS (DC to 5 kHz) or ±5 VDC input for zero to full voltage output
- **External Gain Control:** 0 to ±7.07 VDC provides zero to full output
- External Input Impedance ≥ 30 kΩ

ORDERING INFORMATION			
MODEL NUMBER	OUTPUT POWER RATING	AC INPUT	POWER FACTOR CORRECTION (PFC)
SW 1750A-1	1750 VA[1]	187-264 VRMS (L-L), 3-wire	NO
SW 1750A-2	1750 VA[1]	342-457 VRMS (L-L), 4-wire	NO
SW 1750A-3	1750 VA[1]	187-264 VRMS (L-L), 3-wire	YES
SW 1750A-4	1750 VA[1]	342-457 VRMS (L-L), 4-wire	YES
SW 3500A-1	3500 VA[2]	187-264 VRMS (L-L), 3-wire	NO
SW 3500A-2	3500 VA[2]	342-457 VRMS (L-L), 4-wire	NO
SW 3500A-3	3500 VA[2]	187-264 VRMS (L-L), 3-wire	YES
SW 3500A-4	3500 VA[2]	342-457 VRMS (L-L), 4-wire	YES
SW 5250A-1	5250 VA[3]	187-264 VRMS (L-L), 3-wire	NO
SW 5250A-1	5250 VA[3]	342-457 VRMS (L-L), 4-wire	NO
SW 5250A-1	5250 VA[3]	187-264 VRMS (L-L), 3-wire	YES
SW 5250A-1	5250 VA[3]	342-457 VRMS (L-L), 4-wire	YES

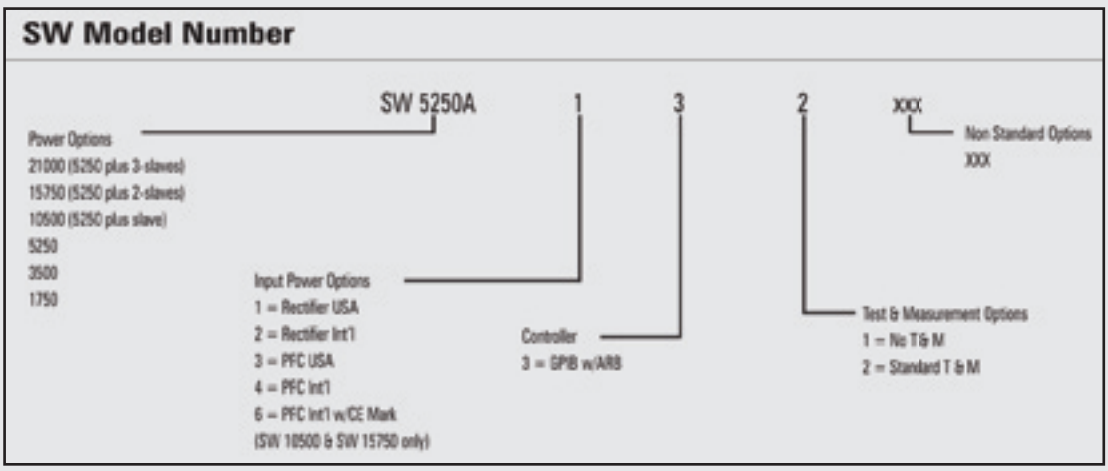
[1] **1495 VA at 115V or 230V output**

[2] **2990 VA at 115V or 230V output**

[3] **4485 VA at 115V or 230V output**

OPTIONS

- Measurement capability
- Input power factor correction to 0.99
- 16A/phase output
- Parallelable for additional power from 10.5 kVA to 21 kVA
- External waveform creation software DSP2
- 5V or 26V, 0.25A auxiliary AC outputs
- Custom cabinets for 10.5, 15.75 & 21 kVA systems
- Interharmonic waveform generator
- Low speed fan option



PRODUCT OVERVIEW

The European Union's EMC directive requires many electronic and electrical products to be tested for immunity and emissions on AC public mains. The SmartWave AE models SW 1750AE, SW 3700AE and SW 5250AE, are an enhancement to the SmartWave Series designed to meet the strict requirements of low frequency AC test sources.

HARMONICS & FLICKER TESTING

The SWAE is especially designed to meet the requirements for testing to EN 61000-3-2/-3-3/-4-13/4-14/4-17/4-28 and pre-compliance only for 4-11. This version provides selectable output impedance in addition to the many standard features of the SW series. The SWAE also features an embedded interharmonics waveform generator.

The SWAE AC Power Source Series is designed to meet the strict requirements for equipment used in susceptibility and emissions testing. In addition to pure sine wave generation, the SW family of power sources can simulate a wide range of line conditions such as sub-cycle and multi-cycle drop-outs, spikes, distorted waveforms, noise, phase shifts and voltage and frequency changes. The SW 1750AE, SW 3700AE and SW 5250AE also feature:

- Selectable output impedance for EN 61000-3-3 testing (single phase)
- Interharmonics waveform generator suitable for EN 61000-4-13 testing
- Immunity test, suites for EN 61000-4-11, 4-13, 4-14, 4-17, 4-28

FEATURES

- Selectable output impedance for EN 61000-3-2 and EN 61000-3-3 testing (Single phase mode)
- Voltage, frequency, current limit, waveform, sequencing
- Single phase 1750 VA, 3700 VA or 5250 VA (1495 VA, 3680 VA or 4485 VA at 230 VRMS)
- Embedded interharmonic waveform generator for EN 61000-4-13 testing
- Immunity tests include Ripple on DC input power port for portable electronic devices

SPECIFICATIONS

Refer to the SmartWave Series, pages 10 through 14, for general descriptions and specifications. The following specifications highlight the differences and enhanced modes of operation.

OUTPUT

Voltage Accuracy: ±0.1% of range. Add ±0.1% of full scale for "AC plus DC" mode. Valid for 5 to 156 VRMS and 10 to 312 VRMS at 25°C, sense leads connected, no load. Temperature coefficient less than 50 ppm/°C

Low Impedance: (Ref: EN 61000-3-3, Annex A and IEC 725)

Low Impedance Mode:

1750 VA 50 Hz	3700 VA 50Hz	5250 VA 50 Hz
1 phase 312V range	1 phase 312V range	1 phase 312V range
<(0.07 + j0.05)Ω	<(0.05 + j0.04)Ω	<(0.03 + j0.03)Ω

Standard Reference Impedance Mode: (0.40+j0.25)Ω ±3% at 50 Hz

Output Frequency: DC or 40 to 500 Hz (SINE); 40-63 Hz (Complex WaveForms)

Interharmonic WaveForm Generator: Ref: EN 61000-4-13

Frequency Range: 15-3000 Hz

Frequency Accuracy: 0.5% (of interharmonic signal)

Frequency Resolution:
15-60 Hz: 0.001 Hz
60-120 Hz: 0.002 Hz
120-240 Hz: 0.004 Hz
240-3000 Hz: 0.008 Hz

Voltage Range: 0-40.0 VRMS

Voltage Accuracy: ±0.23 VRMS

Voltage Resolution: 0.02 VRMS

SMARTWAVE CONTROL SUITE (SWCS)

PRODUCT OVERVIEW

SmartWave Control Suite (SWCS) is a complete Windows® based GPIB control system for the Elgar SmartWave (SW) and SWAE product lines. It provides a very simple method to actively control the SW program. Write and store sequences on your PC; modify, analyze and save waveforms; control the system settings and log measurements to a file on your PC for use in spreadsheet programs.

SWCS program setting screen

The Program Settings Tab is used to control the SW output configuration.

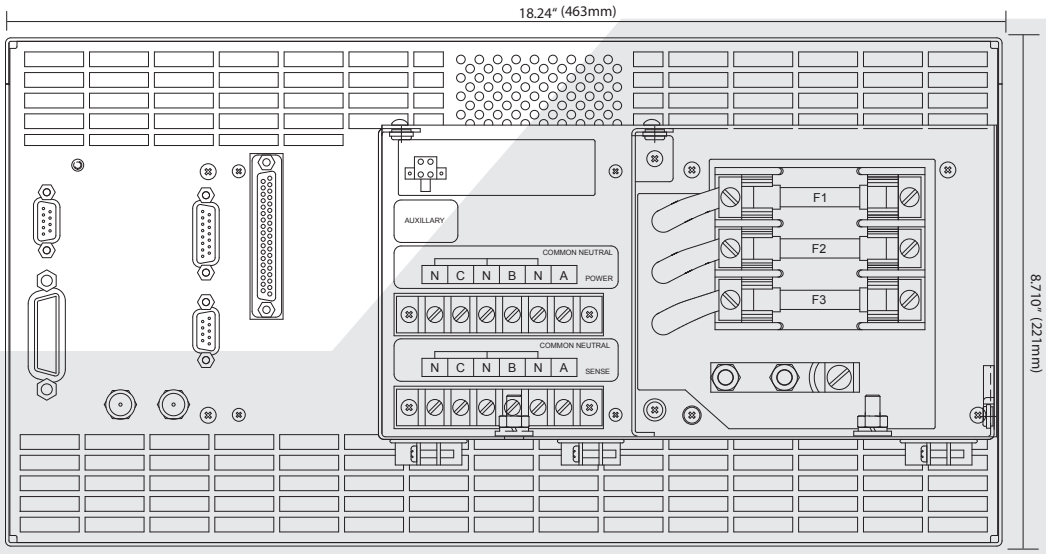
Using the WaveForm Tab, you can edit, analyze and store waveforms in the SW waveform library. (See page 11)

The Sequence Tab, facilitates the generation of new test sequences, modification of existing sequences, and saving sequences to the SW or to the hard drive.

The System Tab provides a remote method of programming important sections of the SW System menu, including the interharmonics generator. (SWAE only)

The Measurement Tab provides strip chart recordings of any four measurements from the SW defined by the user. (SW Series only)

REAR PANEL



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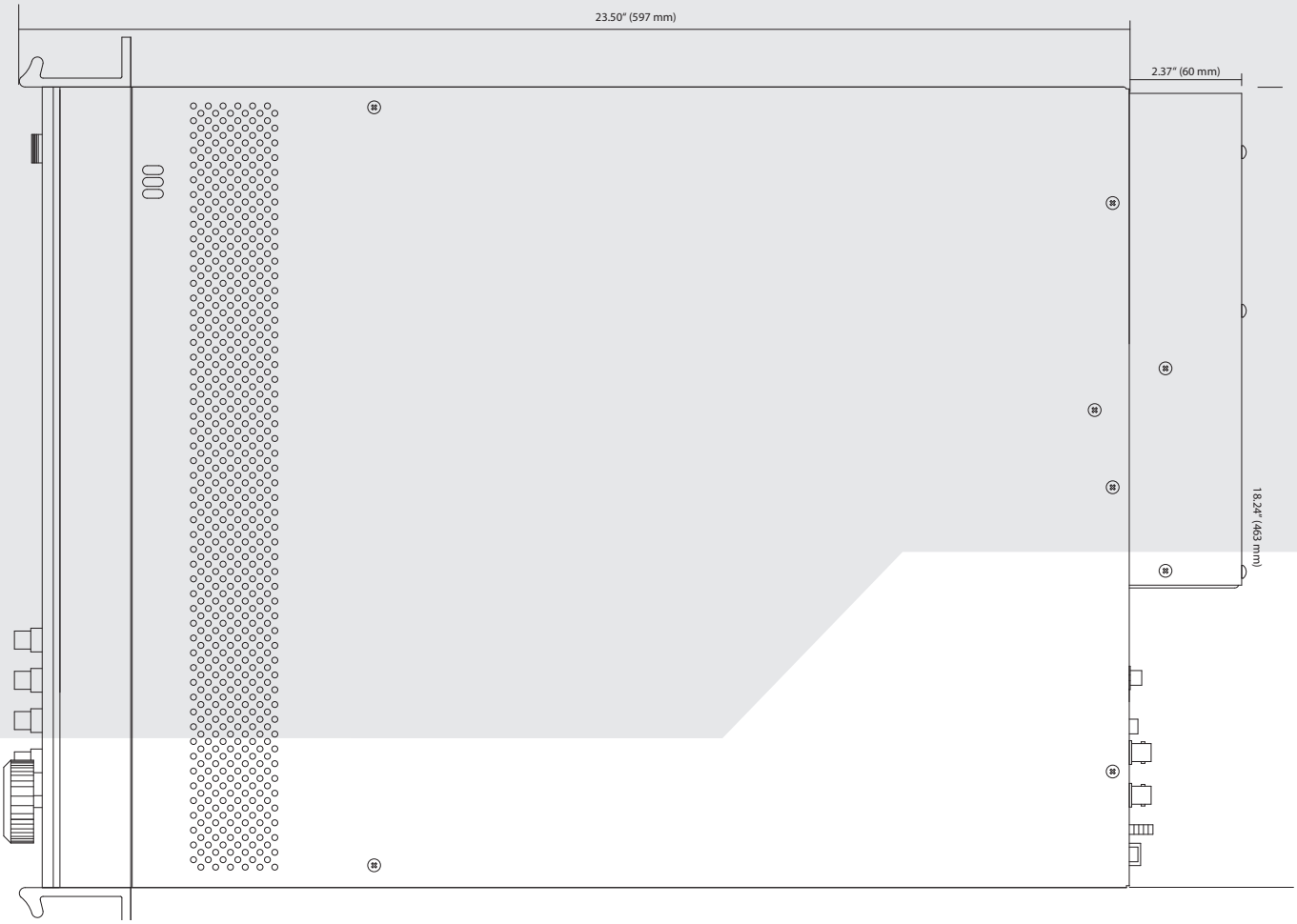
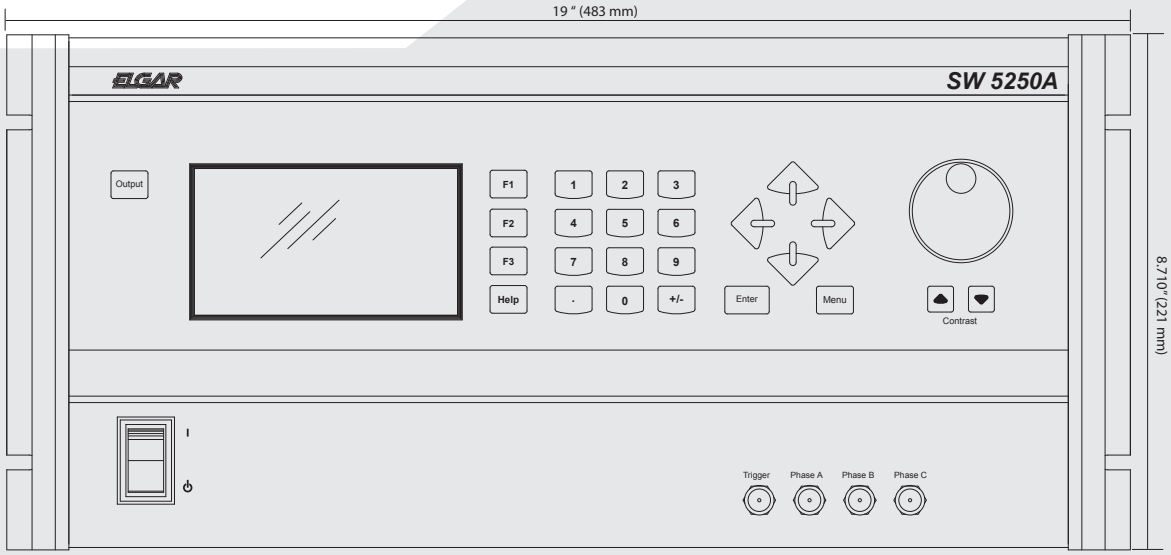


SYSTEM ORDERING INFORMATION		
MODEL NUMBER	**OUTPUT POWER RATING**	**5250 MASTER / SLAVE CONFIGURATION**
SW 10500	10.5 kVA	1 master SW 5250 & 1 slave SW 5250
SW 15750	15.75 kVA	1 master SW 5250 & 2 slave SW 5250
SW 21000	21.00 kVA	1 master SW 5250 & 3 slave SW 5250

FRONT PANEL



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Thurlby Thandar Instruments Ltd. Glebe Road, Huntingdon, Cambs. PE29 7DR U.K.
Tel: 01480 412451, Fax: 01480 450409**,** e-mail: e-mail: sales@tti.co.uk
Web: **www.tti.co.uk**